The Role of Non-invasive Imaging in Women: Best Practice to Diagnose Ischemic Heart Disease

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Disclosure

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Presenter	Disclosure
Mohammad Reza Hojjati, MD, PhD, FSCMR	None

- 44 y old female, no significant past medical history with on and off chest pain for 1 month
  - 1st ER visit, High-Sensitivity troponin protocol, discharged
  - 2nd ER visit, abnormal troponin
  - Medical management, still on and off chest pain and rise in troponin
  - Cath: Significant proximal LAD disease

- Ischemic Heart Disease (IHD) is leading cause of death
- Centers for Disease Control and Prevention data 2017:
  - Cardiovascular Disease death 251.9 per 100,000
  - Breast Cancer death 25.4 per 100,000

- Ischemic Heart Disease (IHD)
  - Obstructive coronary artery disease (CAD)
  - Nonobstructive CAD, dysfunction of the coronary microvasculature and endothelium
    - WISE study: 1 in 3 death in women with nonobstructive CAD

Problems

- The broader spectrum of presenting symptoms in women
- Atypical symptoms
- Higher prevalence of nonobsructive disease
- Worse clinical outcome

Non-Invasive Imaging

- Risk assessment
- Prevention
- Guide clinical management
- Guide for revascularization

Cardiovascular Imaging

- Exercise treadmill testing (ETT)
- Stress echocardiography
- Stress myocardial perfusion imaging (MPI)
  - Single-photon emission computerized tomography (SPECT)
  - Positron emission tomography (PET)
- Stress cardiac magnetic resonance imaging (CMRI)
- Coronary computed tomographic angiography (CCTA)

Niti Aggarwal, Clinical Cardiology, The role of imaging in women with ischemic heart disease

Clinical Cardiology, Volume: 41, Issue: 2, Pages: 194-202, First published: 05 March 2018, DOI: (10.1002/clc.22913)

Jennifer H. Mieres. Circulation. Role of Noninvasive Testing in the Clinical Evaluation of Women With Suspected Ischemic Heart Disease, Volume: 130, Issue: 4, Pages: 350-379, DOI: (10.1161/CIR.0000000000000061)

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Exercise treadmill testing (ETT)

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

- Cardiorespiratory fitness (>10 METs vs <7 METs).
- Blood pressure response
- Chronotropic response
- Heart rate recovery
- No radiation

- Unable to exercise
- Abnormal baseline ECG
- Agency for Healthcare Research and Quality (AHRQ) meta-analysis
  - Sensitivity: 61% (54%–67%)
  - Specificity: 65% (58%–72%)
  - Low positive predictive value
- Unable to evaluate nonobstructive CAD

- Intermediate to high risk
  - Resting ST-segment abnormalities
  - Functional disability
  - Indeterminate or intermediate-risk stress ECG

Stress Echocardiography

- Exercise or pharmacologic
- Wall motion and global systolic function
- Diastolic function
- Pulmonary artery pressure
- Other finding on echo, valvular disease
- No radiation
- Sensitivity: 79% (74%–83%)
- Specificity: 83% (74%–89%)

- Limited acoustic window
- Baseline wall motion abnormality
- Unable to evaluate nonobstructive CAD

- Stress myocardial perfusion imaging (MPI)
  - Single-photon emission computerized tomography (SPECT)
  - Positron emission tomography (PET)

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- Exercise or pharmacologic
- Evaluation of perfusion
- Ejection fraction
- PET: myocardial flow reserve
- SPECT
  - Sensitivity 81%
  - Specificity: 78%
- PET
  - Sensitivity: 92%
  - Specificity: 85%

- Radiation
  - SPECT: ~ 11 mSv
  - PET: ~ 2-3 mSv
- Availability of PET
- Unable to evaluate nonobstructive CAD

Stress cardiac magnetic resonance imaging (CMRI)

Wall motion: Dobutamine

Perfusion: Adenosine, Regadenoson

- Pharmacologic stress
- No radiation
- Two Protocols
  - Wall motion (non contrast) : Dobutamine
  - Perfusion (contrast): Adenosine, Regadenoson
- Ejection fraction
- Late Gadolinium enhancement (viability)
- Sensitivity: 83%
- Specificity: 86%

- Contraindication to MRI
- Contraindication to contrast (Perfusion)
- Availability
- Unable to evaluate nonobstructive CAD

Coronary computed tomographic angiography (CCTA)

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5mm/div
5mm/div
TERARECON

- Nonobstructive disease
- Plaque characteristic (calcified, noncalcified, remodeling)
- Cardiac anatomy and function
- Sensitivity: 93%
- Specificity: 77%

- High-risk features include:
  - Low attenuation plaque (less than 30 Hounsfield Units)
  - Positive remodeling
  - Spotty calcification
  - Napkin ring sign

Ricardo C. Cury, JACC: Cardiovascular Imaging, Coronary Artery Disease - Reporting and Data System (CAD-RADS), Volume 9, Issue 9, September 2016DOI: 10.1016/j.jcmg.2016.05.005

- Radiation: with dose reduction ~ 2-5 mSv
- Iodine contrast
- Tachycardia, Atrial fibrillation, frequent ectopy
- BMI>40

CT in ER

- CT-STAT
- ACRIN-PA
- ROMICAT-II
- CT-COMPARE

CLINICAL RESEARCH — Clinical Trial

The CT-STAT (Coronary Computed Tomographic Angiography for Systematic Triage of Acute Chest Pain Patients to Treatment) Trial

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for the CT-STAT Investigators

Royal Oak and Detroit, Michigan; Tucson, Arizona; Giessen, Germany; Los Angeles, California; Boston, Massachusetts; Minneapolis, Minnesota; Chicago, Illinois; Atlanta, Georgia; and Fort Lauderdale, Florida

CT Angiography for Safe Discharge of Patients with Possible Acute Coronary Syndromes

Harold I. Litt, M.D., Ph.D., Constantine Gatsonis, Ph.D., Brad Snyder, M.S., Harjit Singh, M.D., Chadwick D. Miller, M.D., Daniel W. Entrikin, M.D., James M. Leaming, M.D., Laurence J. Gavin, M.D., Charissa B. Pacella, M.D., and Judd E. Hollander, M.D.

Coronary CT Angiography versus Standard Evaluation in Acute Chest Pain

Udo Hoffmann, M.D., M.P.H., Quynh A. Truong, M.D., M.P.H., David A. Schoenfeld, Ph.D., Eric T. Chou, M.D., Pamela K. Woodard, M.D., John T. Nagurney, M.D., M.P.H., J. Hector Pope, M.D., Thomas H. Hauser, M.D., M.P.H., Charles S. White, M.D., Scott G. Weiner, M.D., M.P.H., Shant Kalanjian, M.D., Michael E. Mullins, M.D., Issam Mikati, M.D., W. Frank Peacock, M.D., Pearl Zakroysky, B.A., Douglas Hayden, Ph.D., Alexander Goehler, M.D., Ph.D., Hang Lee, Ph.D., G. Scott Gazelle, M.D., M.P.H., Ph.D., Stephen D. Wiviott, M.D., Jerome L. Fleg, M.D., and James E. Udelson, M.D., for the ROMICAT-II Investigators

Diagnostic performance and cost of CT angiography versus stress ECG — A randomized prospective study of suspected acute coronary syndrome chest pain in the emergency department (CT-COMPARE) ☆,☆☆

Christian Hamilton-Craig [a,b,d,*], Allison Fifoot [a], Mark Hansen [a], Matthew Pincus [a], Jonathan Chan [a,c], Darren L. Walters [a,b], Kelley R. Branch [d]

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FFRct

Pacific Trial

CENTRAL ILLUSTRATION: Discriminative Ability of Imaging Modalities for the Detection of Per-Vessel Fractional Flow Reserve-Defined Ischemia

Driessen, R.S. et al. J Am Coll Cardiol. 2019;73(2):161-73.

Roel S. Driessen et al. JACC 2019;73:161-173

2019 American College of Cardiology Foundation

Todd Villines, ACC expert analysis, Coronary CTA Should Be the Initial Test in Most Patients With Stable Chest Pain: PRO

Promise Trial

- Among women, a positive CTA vs. a negative CTA was more strongly associated with subsequent clinical events than a positive stress test vs. a negative stress test

- In a meta-analysis of randomized trials, stable chest pain patients who underwent coronary CTA were noted to have a 31% lower risk for MI
- In SCOT-HEART, patients who underwent coronary CTA had a fourfold increase in the use of aspirin or statin therapy.

Table 3. Typical Radiation Exposure, as Measured by an Effective Dose, From Rest-Stress MPI, CCTA, and Angiography in Women

	Effective Dose, mSv
Annual background exposure	≈3
Invasive coronary angiography	≈7
Rest-stress MPI SPECT	
Technetium Tc 99m	≈11
Stress-only MPI SPECT	≈3
Dual-isotope MPI SPECT	22
Rest-stress MPI PET	
Rubidium Rb 82	≈3
Nitrogen N 13	≈2
CCTA	
Overall	≈10
With dose-reduction techniques	<2–5
Coronary artery calcium scoring	2

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Discuss with patient

- Women with nonobstructive CAD or stress test abnormalities should no longer defined as having a false-positive test
- They are at an elevated IHD risk
- The goal of non-invasive imaging is to help us to identify the extent and severity of coronary vascular dysfunction, nonobstructive CAD or obstructive CAD
- Guide for clinical management

Thank you